Paper No. 50

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte FUSEN E.CHEN, FU-TAI LIOU, TIMOTHY E. TURNER, CHE-CHIA WEI, YIH-SHUNG LIN, and GIRISH A. DIXIT

Appeal No. 1998-2671
Application No. 08/480,543

ON BRIEF

Before THOMAS, HAIRSTON, and RUGGIERO, Administrative Patent Judges.

RUGGIERO, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on the appeal from the final rejection of claims 3, 9-13, and 18, all of the claims pending in the present application. Claims 14-17 have been withdrawn from consideration as being drawn to a non-elected invention. Claims 1, 2 and 4-8 have been canceled.

The claimed invention relates to a method for fabricating interlevel contacts in semiconductor integrated circuit devices providing for formation of a contact opening through an insulating layer. A layer of refractory metal is deposited over the insulating layer and within the opening. An aluminum layer is then deposited on the refractory metal layer at a temperature sufficient to cause the aluminum to alloy with the refractory metal to form an aluminum/refractory metal alloy interface layer. Appellants assert at pages 9 and 10 of the specification that, since the formed alloy has a volume greater that the aluminum and refractory metal separately, the contact opening is filled to a greater extent than with previous techniques, thereby improving the planarity of the upper surface of the aluminum layer.

Representative independent claim 10 is reproduced as follows:

10. A method for fabricating interlevel contacts in an integrated circuit, comprising the steps of:

forming an opening in an insulating layer to expose a conductive region beneath;

depositing a refractory metal layer over the insulating layer and within the opening; and

depositing aluminum at a temperature sufficient to cause the aluminum to alloy with the refractory metal at an interface thereof during deposition, wherein the alloy of aluminum and refractory metal has a volume greater than the aluminum and

refractory metal alone, wherein the deposition is performed so that the alloy of aluminum and refractory metal substantially fills the opening, and wherein the deposited aluminum forms a layer without alloy above the opening, the deposited aluminum layer without alloy having a planar upper surface.

The Examiner relies on the following references:

Schilling	4,107,726	Aug. 15, 1978
Mintz	4,661,228	Apr. 28, 1987
Tracy et al. (Tracy)	4,970,176	Nov. 13, 1990 (filed Sep. 29, 1989)
Chen et al. (Chen)	5,108,951	Apr. 28, 1992 (filed Nov. 05, 1990)

Stanley Wolf et al. (Wolf), "Silicon Processing for the VLSI Era, Volume 1: Process Technology", 367-371 (Lattice Press, Sunset Beach, California, 1986).

The rejections of the appealed claims are set forth by the Examiner as follows:

1. Claims 10-11, 13, and 18 stand finally rejected under 35 U.S.C. § 102(b) as being anticipated by Mintz.

2. Claims 3, 9-11, 13, and 18 stand finally rejected under 35 U.S.C. § 103 as being unpatentable over Schilling in view of Wolf.

3. Claims 3, 9-11, 13, and 18 stand finally rejected under 35 U.S.C. § 103 as being unpatentable over Schilling in view of Tracy.

4. Claims 3, 10-12, and 18 stand finally rejected under the judicially created doctrine of obviousness-type double

patenting as being unpatentable over claims 16-18 of U.S. Patent No. 5,108,951.

Rather than reiterate the arguments of Appellants and the Examiner, reference is made to the Briefs[1] and Answer for the respective details thereof.

OPINION

We have carefully considered the subject matter on appeal, the rejections advanced by the Examiner, the arguments in support of the rejections and the evidence of anticipation and obviousness relied upon by the Examiner as support for the prior art rejections. We have, likewise, reviewed and taken into consideration, in reaching our decision, Appellants' arguments set forth in the Briefs along with the Examiner's rationale in support of the rejections and arguments in rebuttal set forth in the Examiner's Answer.

It is our view, after consideration of the record before us, that the disclosure of Mintz does not fully meet the invention as

[1] The Appeal Brief was filed July 31, 1997. In response to the Examiner's Answer dated October 28, 1997, a Reply Brief was filed January 21, 1998, which was acknowledged and entered by the Examiner as indicated in the communication dated January 28, 1998.

recited in claims 10-11, 13, and 18. We are further of the view, however, that the evidence relied upon and the level of skill in the particular art would have suggested to one of ordinary skill in the art the obviousness of the invention set forth in claims 3, 9-11, 13, and 18. Lastly, we are of the opinion that claims 3, 10-12, and 18 are unpatentable, under the judicially created doctrine of obviousness-type double patenting, over claims 16-18 of U.S. Patent No. 5,108,951. Accordingly, we affirm.

Appellants indicate (Brief, page 5) that, for purposes of this appeal, claims 3, 9, 10, and 18 are grouped separately from claims 11-13. With respect to each of the Examiner's rejections, separate arguments for patentability have been provided for independent claim 10 and dependent claim 11. We will consider the claims separately only to the extent that separate arguments are of record in this appeal. Dependent claims 3, 9, 12, 13, and 18 have not been argued separately in the Briefs and, accordingly, will stand or fall with their base claim. Note In re King, 801 F.2d 1324, 1325, 231 USPQ 136, 137 (Fed. Cir. 1986); In re Sernaker, 702 F.2d 989, 991, 217 USPQ 1, 3 (Fed. Cir. 1983). Only those arguments actually made by Appellants have been considered in this decision. Arguments which Appellants

could have made but chose not to make in the Briefs have not been considered [see 37 CFR § 1.192(a)].

The rejection of claims 10-11, 13, and 18 under 35 U.S.C. § 102(b) as being anticipated by Mintz.

Anticipation is established only when a single prior art reference discloses, expressly or under the principles of inherency, each and every element of a claimed invention as well as disclosing structure which is capable of performing the recited functional limitations. RCA Corp. v. Applied Digital Data Sys., Inc., 730 F.2d 1440, 1444, 221 USPQ 385, 388 (Fed. Cir.); cert. dismissed, 468 U.S. 1228 (1984); W.L. Gore and Assoc, Inc. v. Garlock, Inc., 721 F.2d 1540, 1554, 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984).

With respect to independent claim 10, the Examiner attempts to read the various limitations on the disclosure of Mintz, in particular pointing to the illustration in Figure 11 and the accompanying description at column 7, lines 3-53. The Examiner asserts (Answer, page 5) that the aluminum layer 422 deposited at the disclosed temperature of 500° C would necessarily form an alloy with the refractory metal silicide layer 420 and fill the opening in via hole 416.

In response, Appellants argue (Brief, pages 6 and 10) that Mintz does not provide enough refractory metal to form an alloy in order that, in the language of appealed claim 10, "the alloy of aluminum and refractory metal substantially fills the opening...."

After reviewing the Mintz reference in light of the arguments of record, we do not agree with Appellants' initial contention that insufficient refractory metal is provided by Mintz to form an alloy with the deposited aluminum layer. As discussed at column 17, lines 38-43 of Mintz, the TaSilicide refractory layer must be at least 200 angstroms thick, a value within the 100 to 3000 angstrom thickness range disclosed for alloy formation at page 8, lines 27-29 of Appellants' specification.

We do agree with Appellants, however, that, notwithstanding the issue of whether an alloy is formed between the silicide refractory layer and the deposited aluminum in Mintz, there is no basis for concluding from Mintz's disclosure that any such alloy fills the opening 416. It is apparent to us from Mintz's Figure 11 illustration that the refractory metal silicide layer is formed only on the upper sidewall edges of the via hole 416. In our view, any alloy that would be formed with deposited aluminum

would exist only at the interface between the aluminum and the silicide layer which occurs only at the upper portion of the via hole. Any conclusion drawn by the Examiner that a formed aluminum-silicide alloy would migrate from the upper interface portion of the via hole to fill the hole cannot be based on the disclosure of Mintz but, rather, only on unwarranted speculation. In order for us to sustain the Examiner's rejection under 35 U.S.C. § 102(b), we would need to resort to speculation or unfounded assumptions to supply deficiencies in the factual basis of the rejection before us. In re Warner, 379 F.2d 1011, 1017, 154 USPQ 173, 178 (CCPA 1967), cert. denied, 389 U.S. 1057 (1968), rehearing denied, 390 U.S. 1000 (1968). Accordingly, since all of the claim limitations are not present in the disclosure of Mintz, the Examiner's 35 U.S.C. § 102(b) rejection of independent claim 10, as well as claims 11-13, and 18 dependent thereon, is not sustained.

The rejection of claims 3, 9-11, 13, and 18 under 35 U.S.C. § 103 as being unpatentable over Schilling in view of Tracy.

As the basis for this obviousness rejection of representative independent claim 10, the Examiner proposes to modify the integrated circuit structure disclosure of Schilling which describes, particularly illustrated in Figure 1b, the

deposition of aluminum 34 over a refractory metal 32 to fill apertures 24a-24e in insulator layer 22. As recognized by the Examiner, Schilling is silent as to any disclosure of aluminum deposition rate or temperature. To address this deficiency, the Examiner turns to Tracy which provides a two-step aluminum deposition process, the second step including deposition at a temperature of 400°-500° C, to ensure complete coverage of the deposited metal in a via or contact hole. In the Examiner's line of reasoning (Answer, page 6) the skilled artisan would have been motivated and found it obvious to deposit the aluminum in Schilling at the temperature suggested by Tracy, i.e. 400°-500° C, in order to provide full metallization coverage in the contact opening. The Examiner further asserts that, from the evidence of record including statements at pages 8 and 9 of Appellants' specification, the deposition of aluminum at the 400°-500° C temperature range suggested by Tracy would necessarily form an alloy with the underlying refractory metal layer.

Appellants' arguments in response can be summarized from the following statements from page 11 of the Brief:

> Nothing in either reference suggests the use of high temperature deposition over enough refractory metal to substantially fill the opening with alloy.
> Although the combination of previously separately known steps, in accordance with the

> claimed method, would of course result in the claimed process, nothing in the references suggest such a combination.

After reviewing the arguments of record, we are in general agreement with the Examiner's position as stated in the Answer to which we add amplifying comments which follow. Initially, contrary to Appellants' contention, we find clear suggestion in the cited references for the Examiner's proposed combination. It is clear from the disclosure of Schilling, especially the illustration in Figure 1b, that full coverage of the contact hole 24 with deposited metal is contemplated, although Schilling is silent as to any particular deposition temperature for which to achieve such full coverage. We are convinced, however, that the skilled artisan using Schilling's technique, and seeking guidance as to the proper deposition temperature to achieve the desired full contact hole coverage, would have been led to the teachings of Tracy which suggests the proper deposition temperature to achieve the desired full coverage result.

Further, from all of the evidence of record, we are of the opinion that the application of the 400°-500° C deposition temperature range teaching of Tracy to the full coverage metal deposition process of Schilling would necessarily result in the alloying of the aluminum and refractory metal layers, thereby

meeting all of the requirements of appealed claim 10. In this regard, we reject as being unfounded Appellants' argument that no teaching exists in the prior art to provide enough refractory metal to form an alloy to fill the contact hole opening. The thickness of the refractory metal layer 32 of Schilling is disclosed at column 2, line 60 as being 1800-2000 angstroms thick, or within the 100-3000 angstrom range contemplated by Appellants for their refractory layer (Specification, page 8).

Since, for all of the above reasons, it is our opinion that the Examiner's prima facie case of obviousness remains unrebutted by any persuasive arguments from Appellants, the Examiner's 35 U.S.C. § 103 rejection of representative claim 10, as well as dependent claims 3, 9, and 18 which fall with claim 10, is sustained.

Turning to a consideration of the obviousness rejection of separately argued representative dependent claim 11, and claims 12 and 13 dependent thereon, directed to the formation of a refractory metal compound layer underneath the deposited refractory metal layer, we sustain this rejection as well. Our review of Schilling indicates a clear disclosure of a refractory metal compound layer (platinum silicide layer 30) formed under refractory metal layer 32.

The rejection of claims 3, 9-11, 13, and 18 under 35 U.S.C. § 103 as being unpatentable over Schilling in view of Wolf.

In this obviousness rejection, the Examiner uses an identical rationale as that applied to the proposed Schilling-Tracy combination discussed supra. Instead of relying on Tracy for the teaching of increased deposition temperature for improved metal coverage, the Examiner relies on Wolf to provide the identical teaching (Answer, page 7).

Appellants, for their part, essentially repeat their arguments made with regard to the combination of Schilling and Tracy, which arguments our previous discussion found to be unpersuasive. Our review of the Wolf reference reveals a clear teaching (e.g. page 369) of increasing the metal deposition temperature in order to provide improved step coverage. Further, the evidence of record indicates that alloying will occur between deposited metal and a refractory metal layer at the deposition temperature, i.e. ›250° C, suggested by Wolf. Accordingly, the Examiner's 35 U.S.C. § 103 rejection of representative dependent claim 11 based on the combination of Schilling and Wolf, as well as dependent claims 12 and 13 which fall with claim 11, is sustained.

The rejection of claims 3, 10-12, and 18 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 16-18 of U.S. Patent No. 5,108,951.

Appellants attack the Examiner's position by asserting (Brief, page 9) that the claims of the '951 patent do not make obvious the present appealed claims and, under the two-way test required under this double patenting doctrine, the present appealed claims do not make obvious the '951 patent claims 16-18.[2] We do not agree and, therefore, sustain the Examiner's rejection.

In the first instance, we agree with the Examiner that sufficient evidence exists to support the conclusion that the metal deposition process defined by claims 16-18 of the '951 patent in which aluminum deposited at a temperature between 350° and 500° C will necessarily form an alloy with the refractory metal barrier layer to fill the opening in the insulator layer.

With regard to Appellants contention that a two-way obviousness test is required, we are not convinced that Appellants have provided persuasive evidence that the conflicting claims could not have been filed in a single application nor of

[2] As pointed out by Appellants, the present application was filed before the effective filing date of the '951 patent.

any administrative delay by the Office. Notwithstanding our misgivings about the justification for Appellants' assertion of the requirement for a two-way test, we nevertheless are convinced of the obviousness of the '951 patent claims 16-18 over the present application. In our view, the alloy formation at the prescribed aluminum deposition temperature disclosed in the present application would necessarily cause the deposition process with the same prescribed temperature set forth in the patent claims to fill the insulator opening with the formed alloy. The language of '951 patent claim 16 which, as alluded to by Appellants, describes the migration of aluminum into the insulator opening does not preclude the migration of a formed alloy into the opening as well.

In summary, we have not sustained the Examiner's 35 U.S.C. § 102(b) rejection of claims 10-11, 13, and 18. We have, however, sustained the 35 U.S.C. § 103 rejections of claims 3, 9-11, 13, and 18, as well as the obviousness-type double patenting rejection of claims 3, 10-12, and 18. Therefore, the Examiner's decision rejecting all of the appealed claims 3, 9-13, and 18 is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED

JAMES D. THOMAS Administrative Patent Judge	)	
KENNETH W. HAIRSTON Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
JOSEPH F. RUGGIERO Administrative Patent Judge	)	

lp

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